# Valuation of Ecological Services

- Introductions
- Plan for the Morning

# Word Association: “Environmental Valuation”?

- “Monetization” of benefits
  - Representing environmental services in $$$$
- What benefits to monetize and how to do it?

# What to Monetize – An Enduring Question

- Federal government should participate in the provision of flood protection
  - "…if the benefits to whomsoever they accrue are in excess of the costs and the lives and social security of the people would be otherwise adversely affected."
- Developing the analytical tools called for by this language challenged Gilbert White and Arthur Maass in the 1930s, challenged those who came before them and the challenge continues today.

# Monetizing Flood Control Benefits

- Changes in Land Values
  - As a basis for cost recovery (1850- 1920s)
  - As measure of willingness to pay (since the 1960s)
- Real property damages avoided
  - As investment logic (Around New Deal)
  - As development stimulus (Around New Deal)
  - As measure of willingness to pay (since the 1960s)
  - As a fiscal matter (avoided disaster payments) – recent
- Intangibles
  - Acceptable risk to real property
  - Avoided Pre flood anxiety
  - Avoided Post flood trauma
  - Community vitality
  - Other measures of “lives and social security of the people”

# Many Benefits are not Routinely Monetized In Corps Planning

- **Navigation**
- **Flood hazard**
- **Power generation**
- **Water Supply**
- **Commercial Harvest**

- **Recreation**

- **Process or sequester waste**
- **Avoided emissions**
- **Aesthetic beauty**
- **“life support” services**

# Monetization is on the Corps "Radar Screen"

- Corps has been a sponsor for
  - NRC 216 Studies
  - NRC report on valuation
  - Booz-Allen briefing at IWR
  - On-going interagency meetings
- EPA
  - SAB
  - NCEE sponsored research and workshops
- OMB - Circular A-4 revision
- IWR Research Program
  - EEIRP Program (started in 1993)
  - Improving Environmental Benefits Analysis in Ecosystem Restoration Planning

# This Morning

- Logic and Foundation for Monetization
- Highlight Monetization Critiques
  - Technical
  - Conceptual
  - Philosophical
- Suggest Constructive and Practical Alternatives to Full Monetization

# What is Being Monetized?

- Peoples preferences for different states of the environment
  - For reduced flood hazard
  - For more quicker bulk commodity transportation
  - For a day of successful fishing
  - For the existence of the Florida panther
  - Etc.
- Preferences of individuals are aggregated for the affected population

# What is the Logic?

- In a market, money income  is sacrificed (a price is paid) to secure some good or service.
- Prices that people are willing to pay are revealed from choices made in markets
- If peoples preferences guide their market choices, then the prices they pay are evidence for what they prefer

# Price of Everything, … Value of Nothing?

- A market price is “Marginal  Willingness to Pay”.
- Value is “Total Willingness to Pay”
  - A more abstract idea, derived from observed marginal willingness to pay
  - Income you would be willing to pay, but do not have pay, to receive the good or service

- Benefit monetization is using this underlying conceptual foundation to
  - develop analytical processes
  - to select and collect data
  - to analyze the data
- with the purpose of measuring preference satisfaction in dollar terms

# What Does this Have to do with Corps Planning?

- The National Economic Development Account (NED) is expected to be a measure of willingness to pay
  - “The general measurement standard of the value of goods and services is defined as the willingness of users to pay for each increment of specific goods and services from a plan. Such a value would be obtained if the seller of the output were able to apply a variable unit price apply a variable unit price and charge each user an individual price to capture the full value of the output to the user. “

# What Does this Have to do with Corps Planning?

- Measuring WTP is what the P&G is about
  - "Since it is not possible in most instances for the planner to measure the actual demand situation, .. alternative techniques can be used to obtain an estimate of the total value of the output of a plan."

# What Does this Have to do with Corps Planning?

- If the Corps fully monetizes  all outputs of an alternative, then the value of all environmental services is measured within the NED account.

# Not all $$ Measurements are Willingness to Pay

- Impact Assessment
- Alternative cost
- Production (Input) Basis
  - Energy Theory of Value

# Impact Assessment

- The amount of money spent on fishing by people who visit a reservoir and the jobs, business profits and local tax revenues that result  is NOT a measure of willingness to pay.

- The stimulus an activity creates in a national or a regional economy, as measured by increases in wages, rents and profits is NOT a measure of willingness to pay

# What Does this Have to do with Corps Planning?

- Many local sponsors think impact assessment that is represented in $$$ is what is meant by economic analysis
- Many proponents of Corps projects think economic analysis is about creating jobs and investment.
- Neither is NED

# $$$ Cost of the Most Likely Alternative

- Saved by making an expenditure now to avoid a future expenditure
  - Avoided flood damages
- Spent on one activity to avoid expenditure on another
  - Water supply, power and navigation benefits
- Spent to exactly replace something that has been destroyed
  - Damage compensation

# What Does This Have To Do With Corps Planning?

- “The replacement cost method and estimate of the cost of treatment are not valid approaches to determining benefits and should not be employed to value aquatic ecosystem services.”
- Alternative cost is a WTP benefit only under restrictive conditions – many in P&G
  - Debate over tow cost vs. GEM
  - Debate over benefits of flood plain evacuation
  - Debate over how to value wetlands as sediment trap

# Single Input Theory of Value

- " Economic valuation, as currently practiced, can never be used appropriately to evaluate environmental capital, its contributions or its impacts. … We suggest that the best way to do this is to use one kind of energy as the common denominator." Odum and Odum, 2000
- Emergy
  - GNP =f (all energy input)
  - Associated with Odom's and advanced by Robert Costanza in the past
  - Recalls classical economists search for value in land and labor (labor theory of value)

# What Does this Have to do with Corps Planning?

- Promoted vigorously, found on the web and elsewhere and might be advocated inside the agency.
- Widely dismissed by virtually all professional economists as a dollar measure of benefits.

Science and Technique of Benefit Monetization

Development of Benefit Indicators

Valuation as Learning -- Discovery (collaboration and mediated modeling)

# This Section

- Describe ‘willingness to pay’ (WTP) methods
- Explore the drawbacks to WTP methods
  - Technical
  - Pragmatic: my focus
  - Philosophical
- Motivate alternatives

# The Basic Goal

- Ecosystems are bundles of benefits
  - ‘Natural factories’ producing multiple outputs
  - Ecosystem services = outputs
- What is the total benefit of ecosystem services produced by a given site?
  - Attach benefits to individual services

# Building Blocks

- Biophysical analysis is the foundation
  - Describe the “production function”
  - What are the “outputs” of the natural factory?
- Economic analysis used to evaluate what outputs are worth
  - The willingness to pay for those outputs

# The Science & Technique of WTP Economics

- Economic Principles
- Data
- Formal Models
- Econometric Estimation
- A Monetary Endpoint

# Not One Method, a Collection

- Revealed preference methods
  - Infer from real-world actions
    - Travel costs
    - Property prices
- Stated choice methods
  - “Simulate” a market
    - Contingent valuation
    - Conjoint analysis

# The Travel Cost Method

- How much time and money do people spend on “ecological recreation”?
- This tells us something about how much the ecological assets are worth

# Hedonic Analysis

- People pay more to be near certain ecological amenities
- This amount can be statistically estimated from the sales price of property

# Contingent Valuation

- Ask people to make choices involving environmental goods
- Infer ecological value from simulated choices

# WTP: A Critique

- Analysis as technique
  - Leave aside
- Analysis as an activity
  - Supplying analysis, implications for agencies
- Analysis as decision support
  - Using economic analysis in decision-making, as argument

# WTP as Technique

- Issues with each method
  - Criticism of methods within economics
  - Active criticism of individual studies
- But our complaint is not with the techniques
  - Nothing is broken here

# WTP as an Activity

- Are we at a point where we can “crank it out”
- Can we think of ecological valuation as a field office or line function?
- No, several things defeat this

# (1) Who does WTP?

- Analysis depends on specialized economic training
- A small set of qualified practitioners
- Expertise does not translate across methods
- Not brain surgery, but organized like it

# (2) What is the Ecological Foundation?

- What is the ecological lift (loss) being valued?
  - How many birds will be saved? How much will water quality improve?
- Much of ecology doesn't directly address these issues
  - The "endpoint problem"
  - Ecology rejects the presumption of valuation
- Biophysical analysis is as difficult as the economics
  - And probably more balkanized

# (3) Assessment is Place-Based

- Good analysis is not spatially transferable
  - For ecological reasons
  - For economic reasons

# WTP as an Agency Activity

- Expensive
- Time-consuming
- Dependent on multiple sets of experts who tend to be uncoordinated

# Rationale for “Benefit Transfer”

- Do it once, apply it elsewhere
  - Cheap, quick, easy
- But unsound unless precautions are taken
  - Biophysical & economic adjustments
- Re-introduces the complexity we were trying to avoid

# The NRDA Lesson

- Large scale damages, large scale resources, legal authority
- What kind of analysis is done?
  - Experiments with CV (failed, largely)
  - Replacement cost methods (e.,g., HEA)

# Replacement Cost

- “The replacement cost method and estimate of the cost of treatment are not valid approaches to determining benefits and should not be employed to value aquatic ecosystem services”

  - The NRC Aquatic Valuation Report

# The NRDA Lesson

- Replacement cost is used here, despite deep qualms within economics
- A cautionary tale

# WTP as Decision Support

- WTP's decision impact is limited
  - The models problem
  - Other  problems (Len)
- All relate to its credibility and effectiveness as a form of argument

# The Models Problem:

- Economic techniques *from the standpoint of decision-making* yield
  - Bad Simplicity
    - Formality requires problems to be bounded
  - Bad Complexity
    - Arises from formality necessary for science
- In a nutshell, the environmental valuation is
  - Narrow & Confusing

# Aren't All Models Narrow & Confusing?

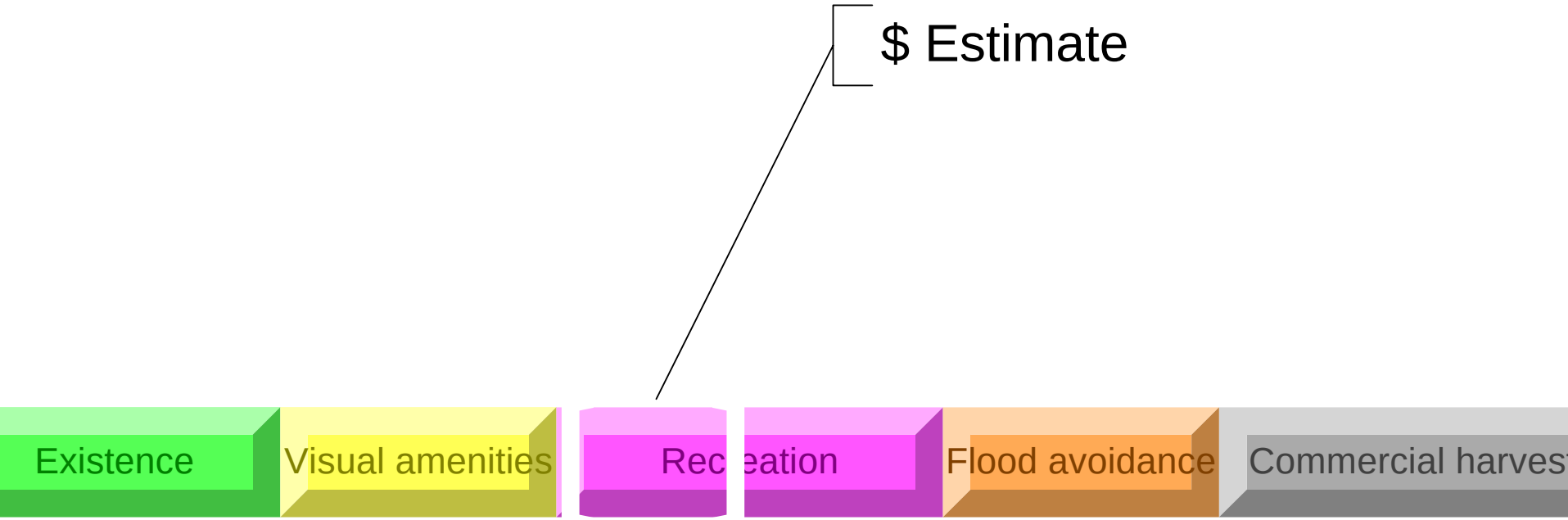
- Narrowness is particularly problematic
  - The distinctive complexity of ecological systems
  - Our audiences demand holism
- Methodological complexity is particularly problematic
  - Communicating outside economic discipline is fundamental to credibility
  - To bridge the economics-ecology divide

# Bad Simplicity

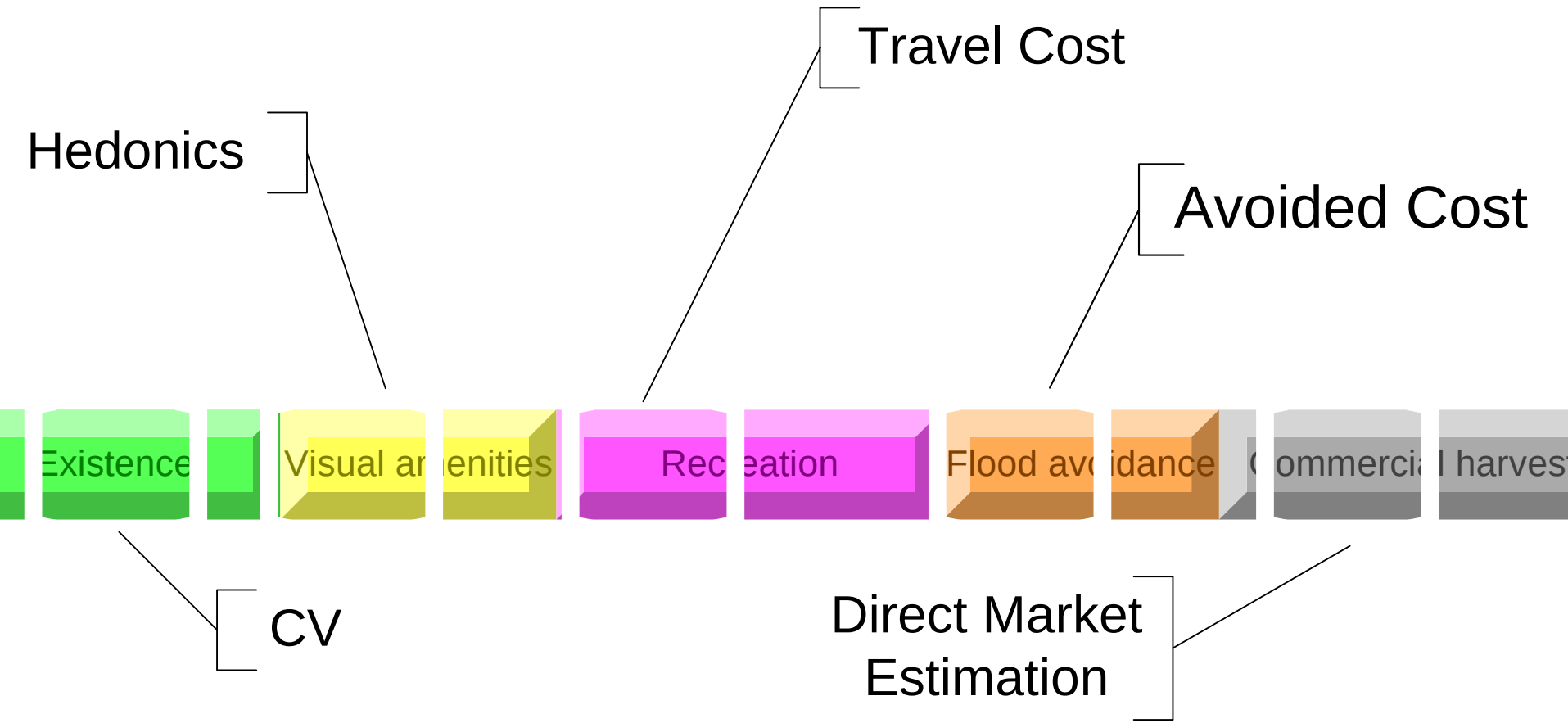
- Simplicity is achieved by narrowing the scope of a scope of ecological benefits captured in a given study

# (Part of) The Spectrum of Services

# The Spectrum of Services



# The Spectrum of Services



# Narrowness

- An unfair criticism to level at science of environmental valuation
- A legitimate criticism of valuation as a decision tool

# Models: Bad Complexity

- Mathematical & statistical discipline is necessary to the scientific mission
- But models are opaque to non-practitioners
  - Un-democratic, intimidating, suspicious
  - Obscure the principles at their core
- Assessment is
  - Expensive
  - Time-consuming
  - Dependent on small professional community

# The Hypothesis

- Environmental valuation is
  - Not holistic enough
  - Overly reliant on opaque, exclusive methods
  - Expensive and slow
  - Not geared to engagement in process
  - And more …
- Is there a constructive alternative to monetization?

- Everyone is not “using monetization” to inform decision making
- There are widely debated philosophical foundations for full monetization
- There are widely debated conceptual assumptions behind monetization of some environmental services

# Everyone else is not leaving the Corps behind

- Agency research programs do not prove use in decision making
- Modest use in broad regulatory rule making does not prove use in making specific regulatory, mitigation and investment decisions

# Mitigating and Compensating for Environmental Damage

- "In context of the wide ranging public debate, NOAA reframed the concept of damages for interim losses in terms of providing compensatory restoration projects.“

  “In the reframed rules the focus on "recovering the costs of compensatory restoration actions rather than the value of interim losses."
    - Jones and Pease, Contemporary Economic Policy, October 1997.

- "Under the NOAA approach, NRD now focuses on remediation of harm rather than monetization of claims"
    - Medina. The  Environmental Forum, (2001):23-29

# EPA Water Quality Management

- EPA's CSO regulations call for an analysis of the appropriate level of pollution control investment to be based on a process it calls "knee of the cost curve" analysis. The analyst calculates the incremental costs of increasingly stringent pollutant controls for a regulatory and stakeholder decision process that judges whether those added costs are justified by the predicted changes in water quality results.

- In setting of ambient water quality standards, that in turn determine private and public investments in water pollution control, EPA does not expect the states to make use of non market benefits analysis. Then, if there is a review of a water quality standard for a given watershed, the analysis to support such a review does not rely upon, and rarely utilizes monetization.

# FERC Dam Re-licensing

- FERC expects an analysis to compare marginal forgone hydro power benefits plus costs of dam modifications with marginal improvements in physical measures of environmental outcomes, as these marginal changes result from changes in dam operations. This marginal cost curve is then used by the FERC commissioners, in conjunction with the owners of the dam and stakeholder groups, to help judge whether the marginal non-monetized environmental benefits are worth the marginal dollar costs.

# Why the Reticence ?

- In some cases
  - Agency Mission
  - Legal restrictions
- In other cases
  - A sense of discomfort

# Hotly Debated Ethical Premises

- Monetary endpoints offend many
  - Deep Ecology vs. Anthropocentric
  - Category error
    - Commodification of nature
- Implicit Equity Judgment
  - Ability to pay
    - Conditions expressions of preferences
    - Flawed basis for preference aggregation
  - Presumed “rights in natural services”

# Conceptual Weaknesses

- WTP assumes stable preferences, but preference are constructed while choosing
  - Neo-Austrians and American Institutionalists
    - Market and democratic processes are *necessary* to learning and preference formation
    - Social Psychologists
  - Particularly true for ecological services
    - Complexity
    - Uncertainty
- The knowledge/ information issue already occupies (haunts) CV practitioners

# Decision Making Utility

- Heat or light?
  - For critics looking for a  dissenting view, it's easy to find one
  - Debate over tools and number is a distraction
- Decision makers – not calculators – need to make the difficult value and interest tradeoff decisions

# An Example

- Compare 2 wetlands
  - If only one can be preserved, which one?
  - Is restoration of one adequate as compensation for loss of another?
- Examine four services
  - Visual amenity
  - Flood damage avoidance
  - Water quality improvement
  - Rare species support

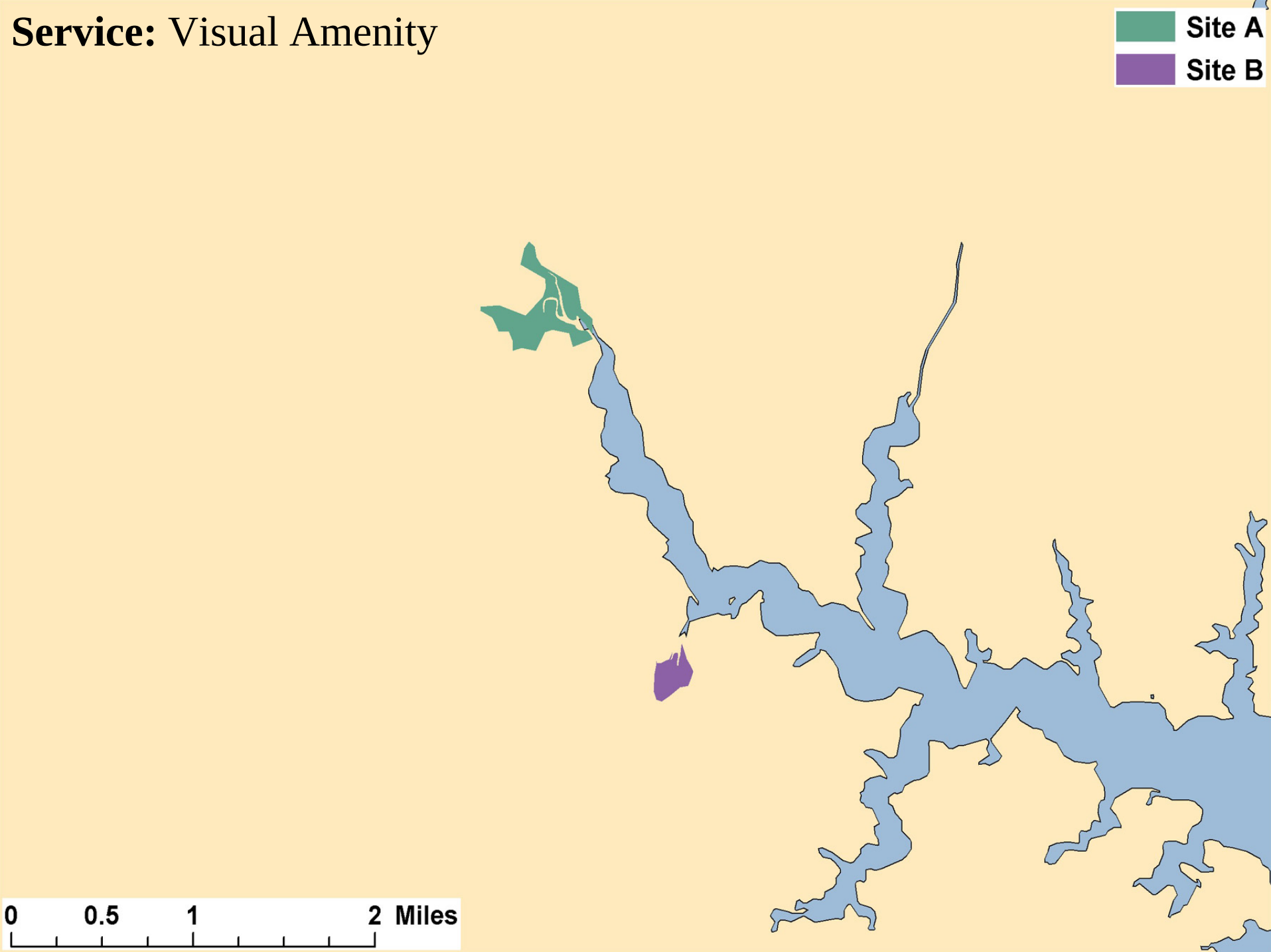
# The Example Method

- Joint work with Lisa Wainger
- Relationship to other indicator research
- For this presentation
  - Data is real, but “adjusted”
  - Only a subset of services
  - Only a subset of service factors

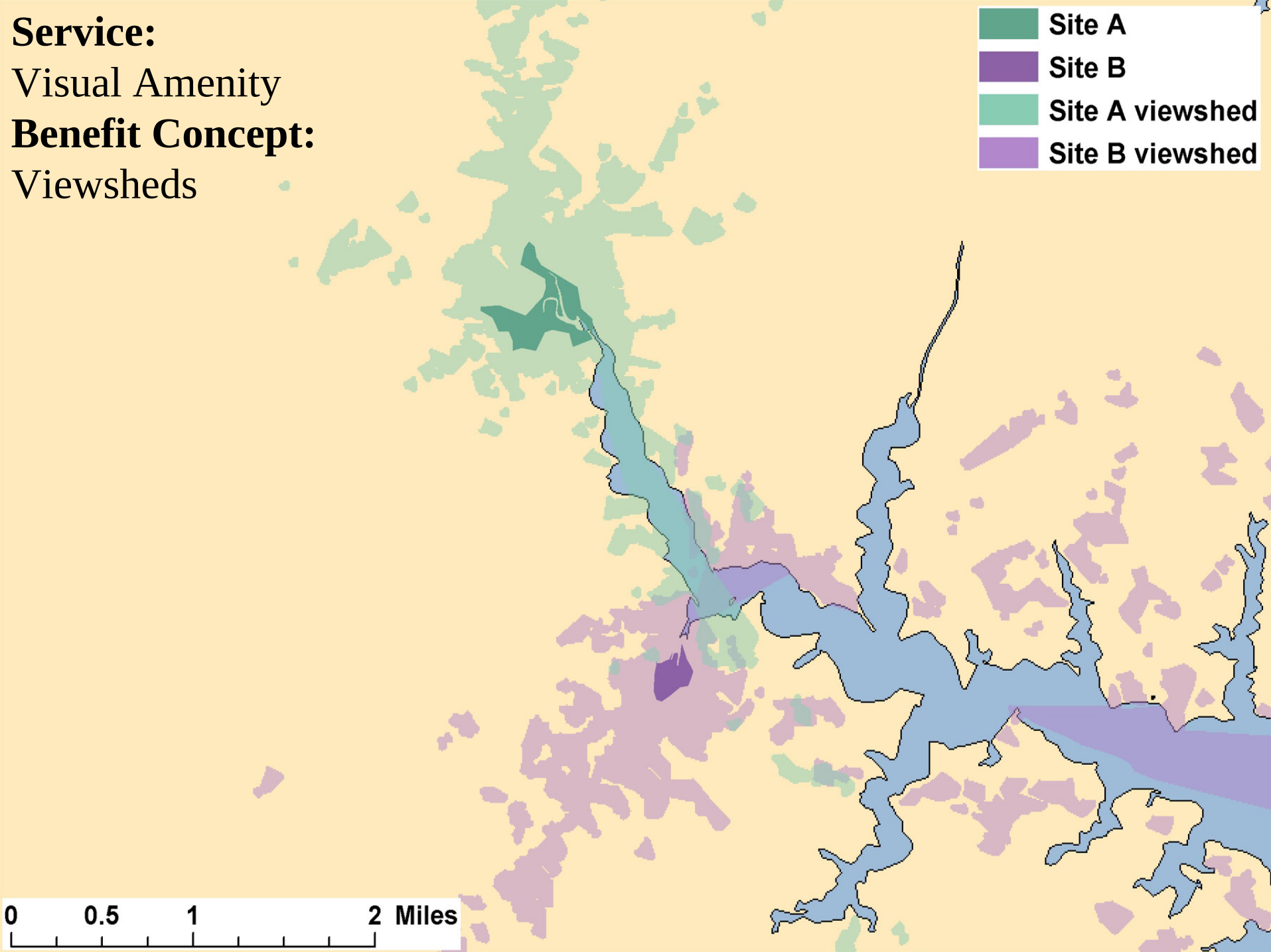
# Maps & Indicators

- Indicators are calculated from spatial datasets
- Visual and quantitative
- Maps as an end in themselves
  - “Benefit hotspots”
- Disaggregated indicators
  - Weighting not illustrated

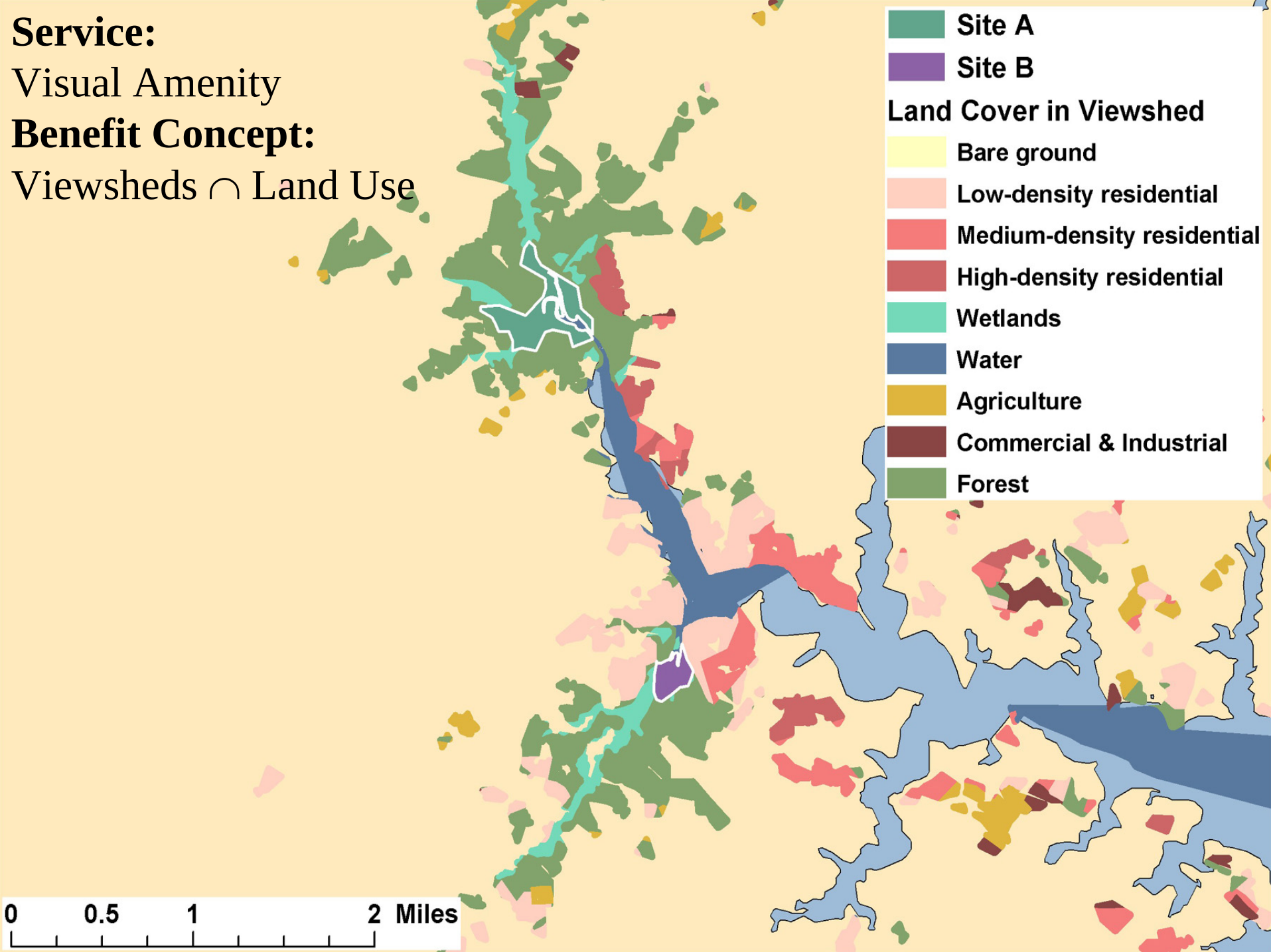
**Service:** Visual Amenity



**Service:**
Visual Amenity
**Benefit Concept:**
Viewsheds



**Service:**
Visual Amenity
**Benefit Concept:**
Viewsheds ∩ Land Use



# Visual Amenity: A Sample Indicator

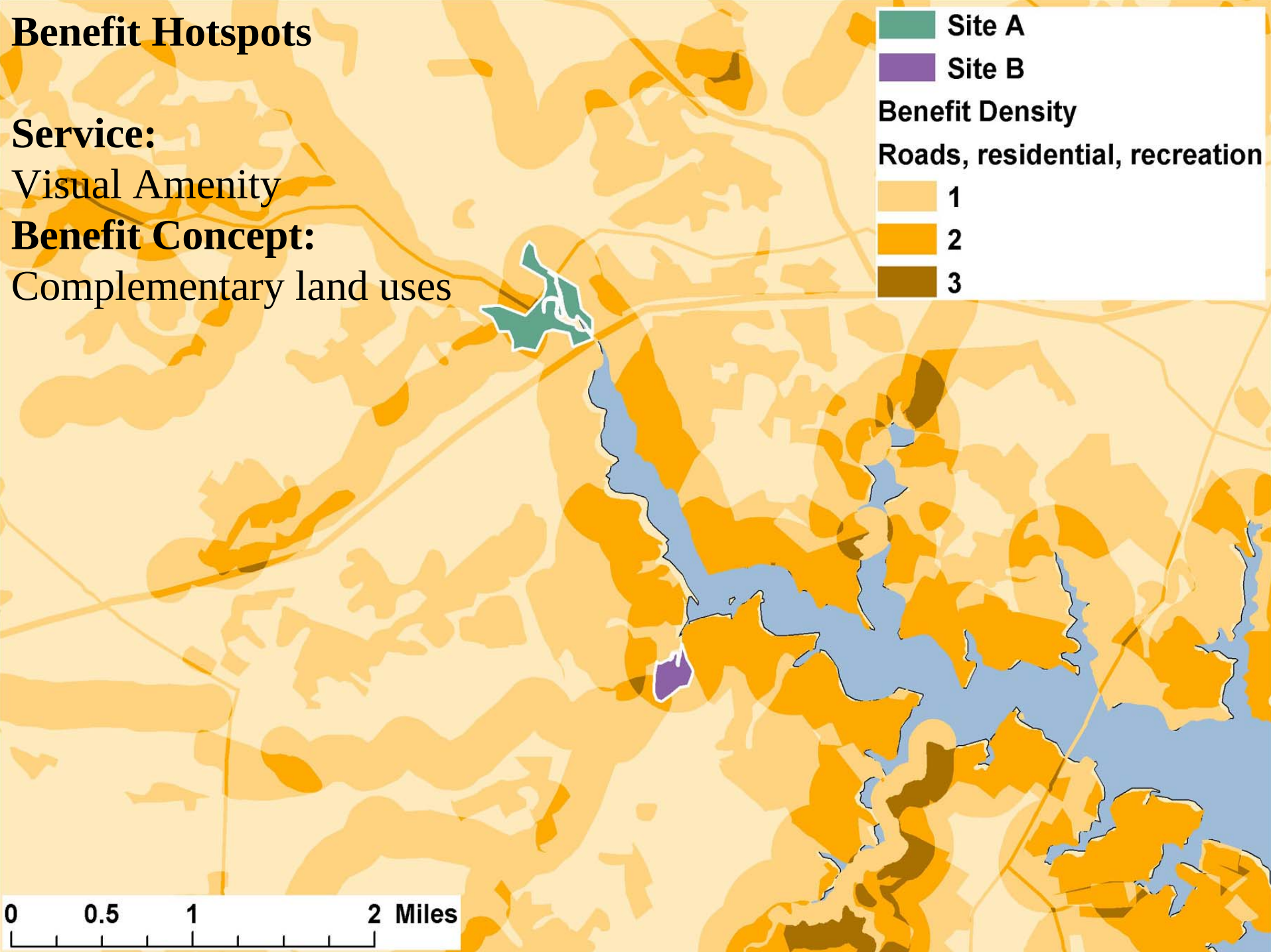
- Demand: Land area in viewshed with land uses complementary to visual enjoyment
  - A: 712 acres  B: 327 acres
- Housing density-weighted land areas

# Other Indicators

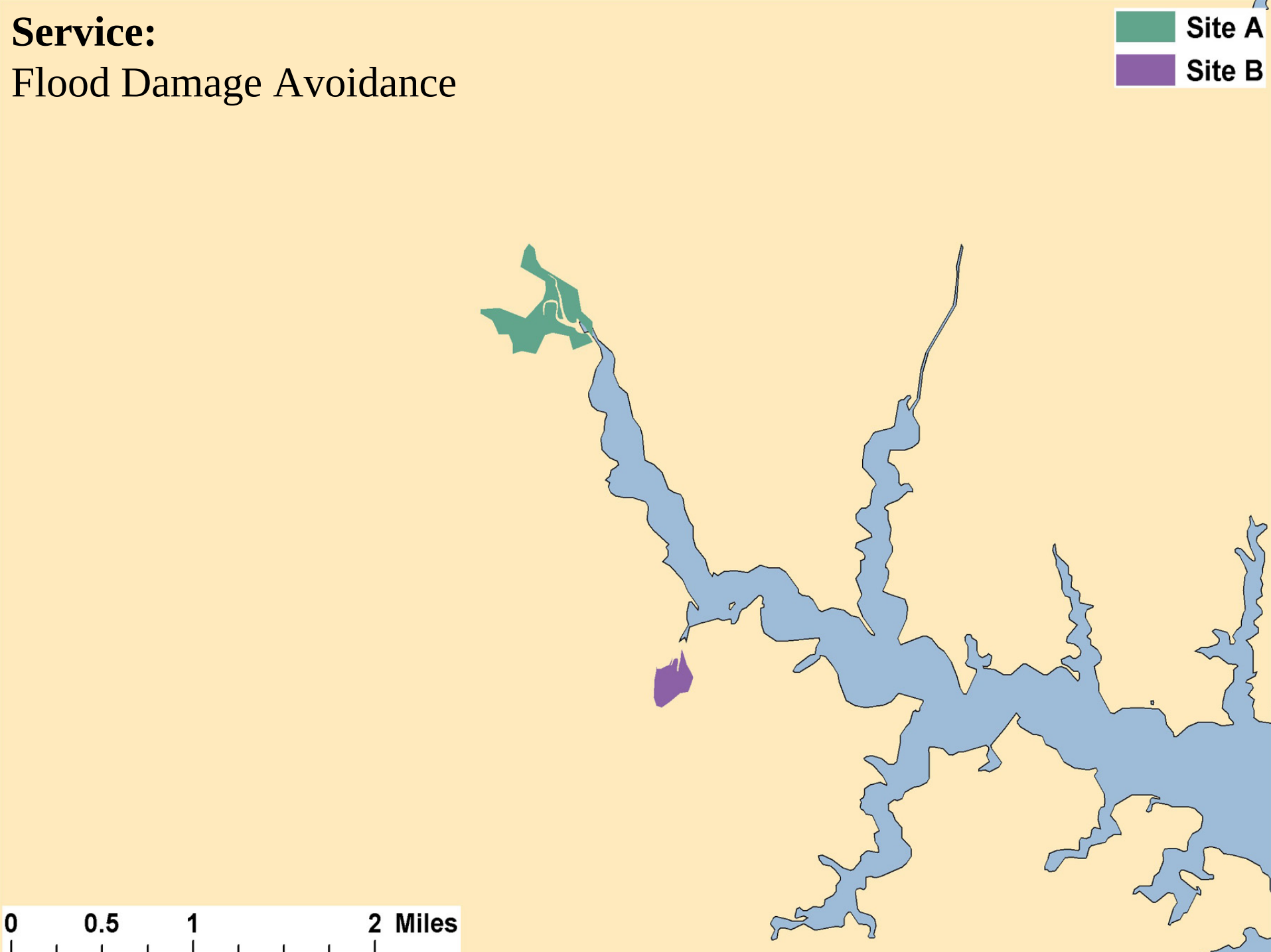
- To convey the relevance of substitutes & scarcity:
  - Acres of natural land area in viewsheds of households
  - Percent natural land area in viewsheds of households

# Benefit Hotspots

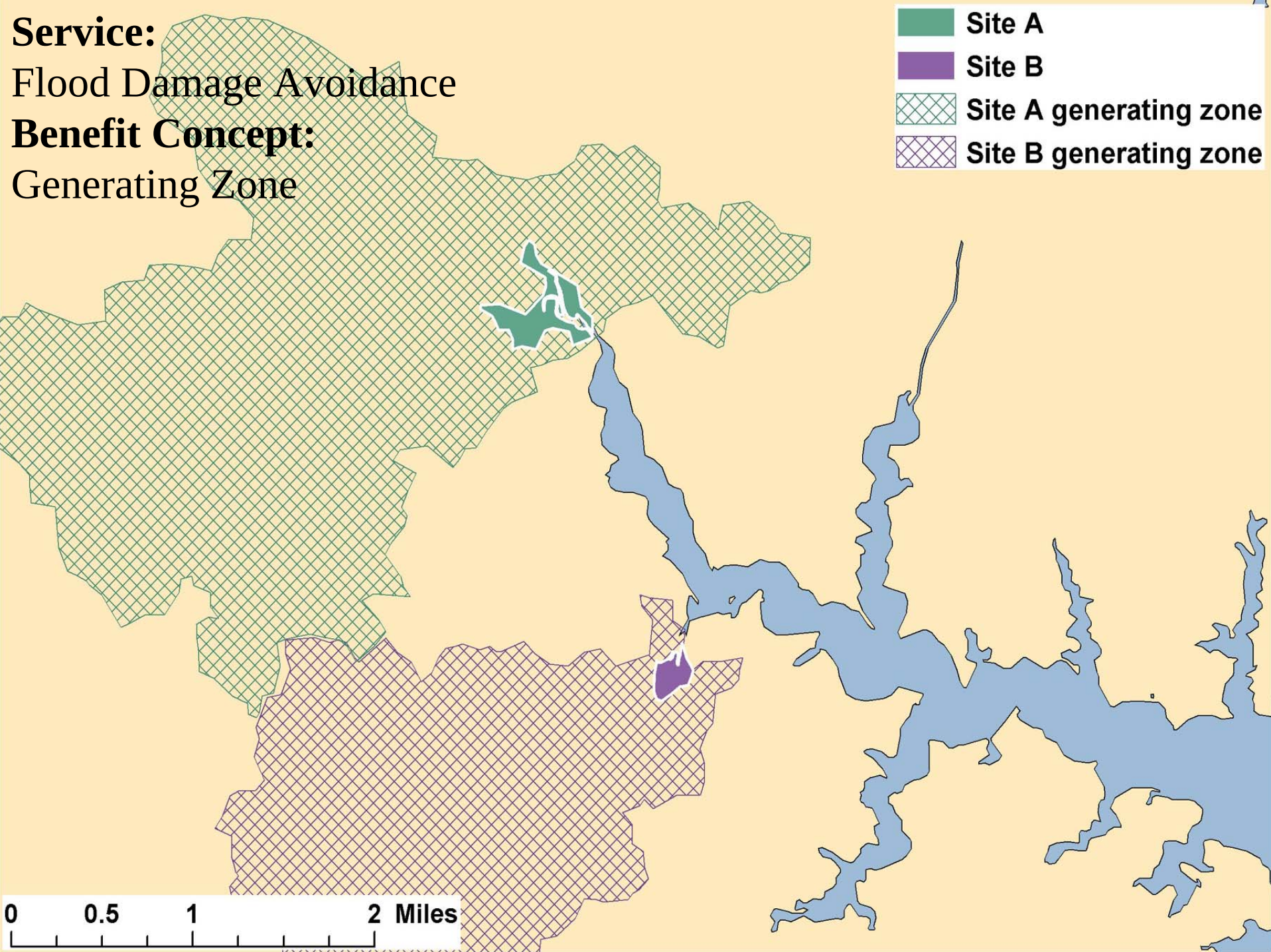
**Service:**
Visual Amenity
**Benefit Concept:**
Complementary land uses



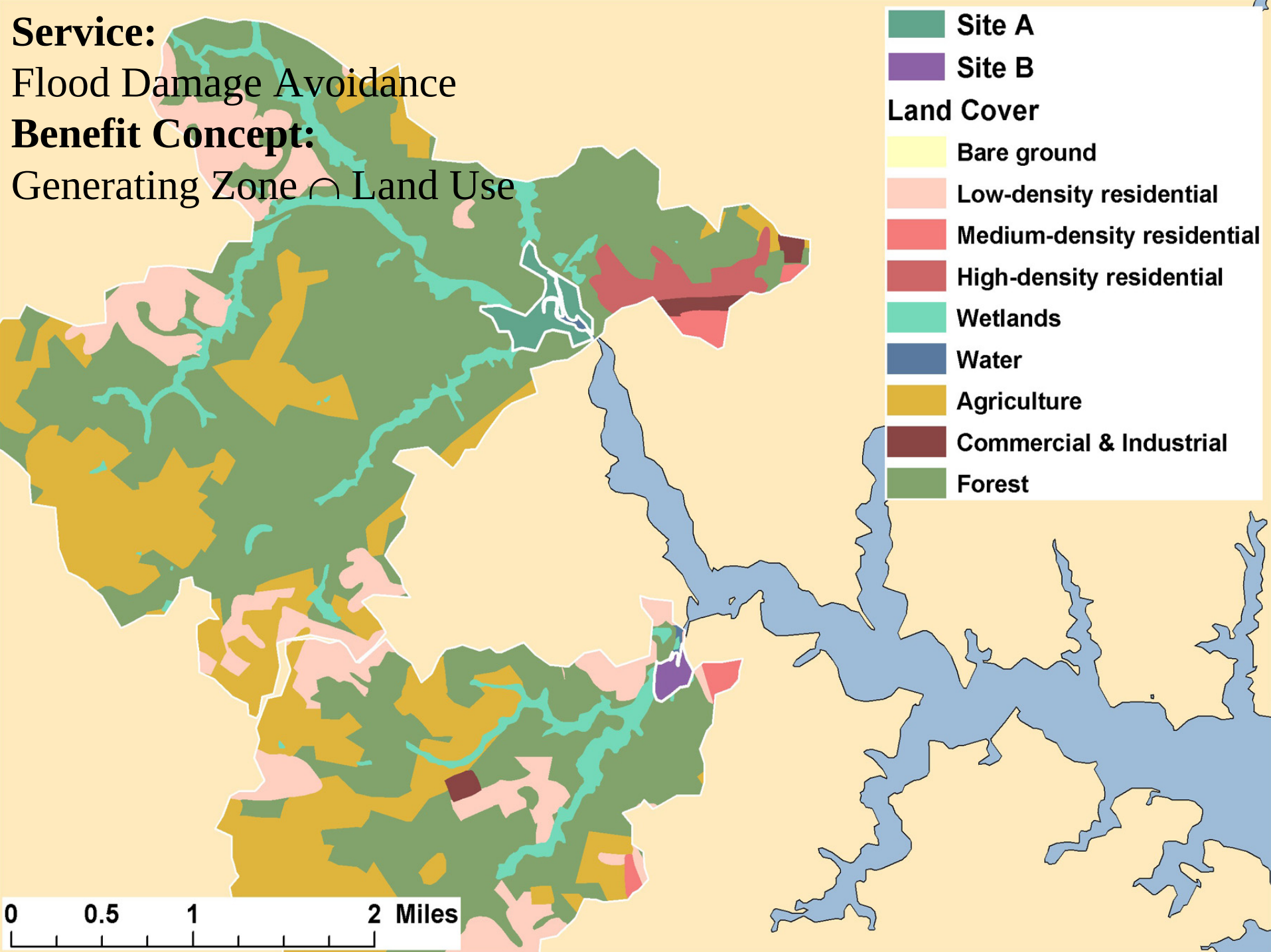
**Service:**
Flood Damage Avoidance



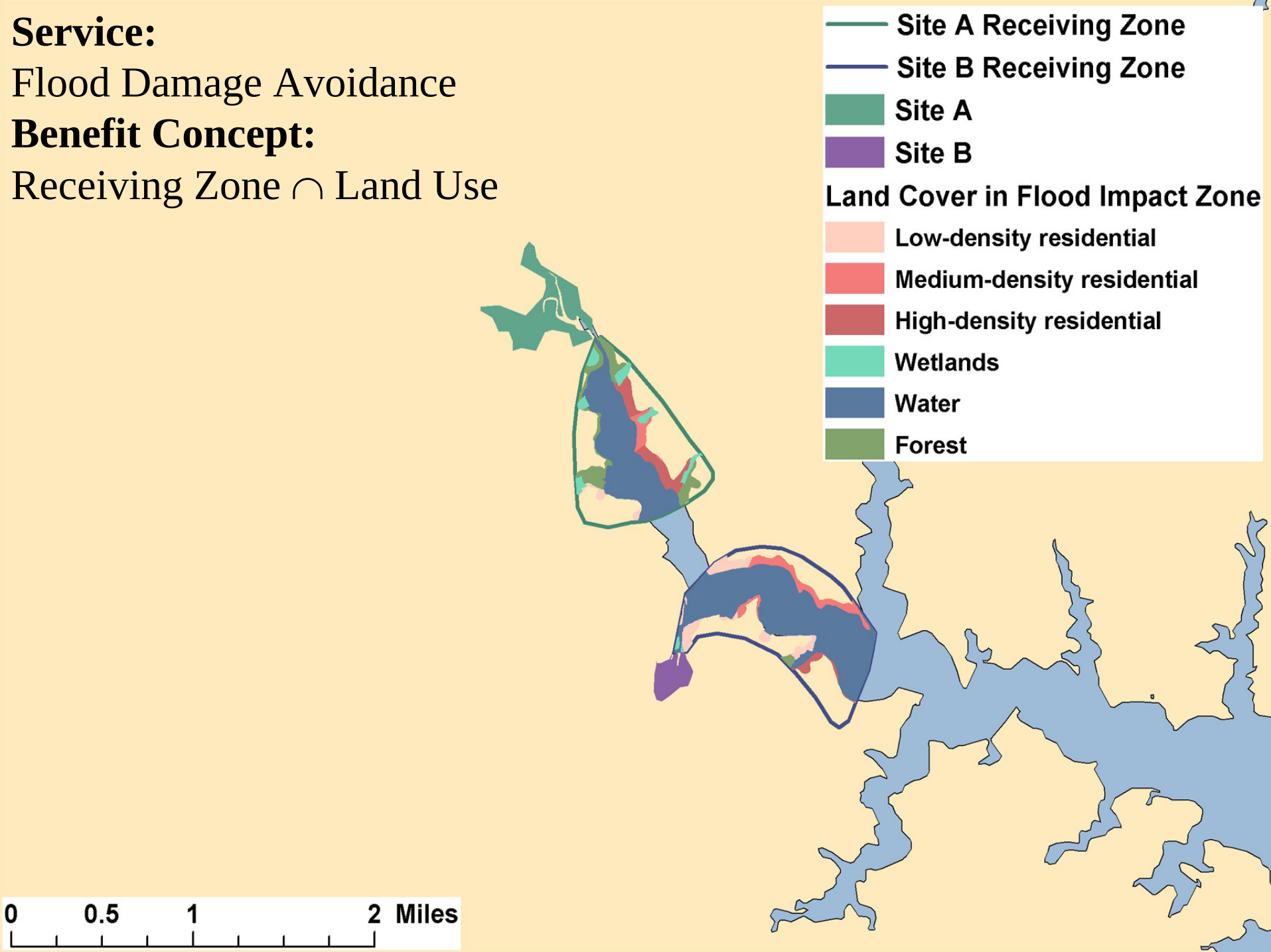
**Service:**
Flood Damage Avoidance
**Benefit Concept:**
Generating Zone



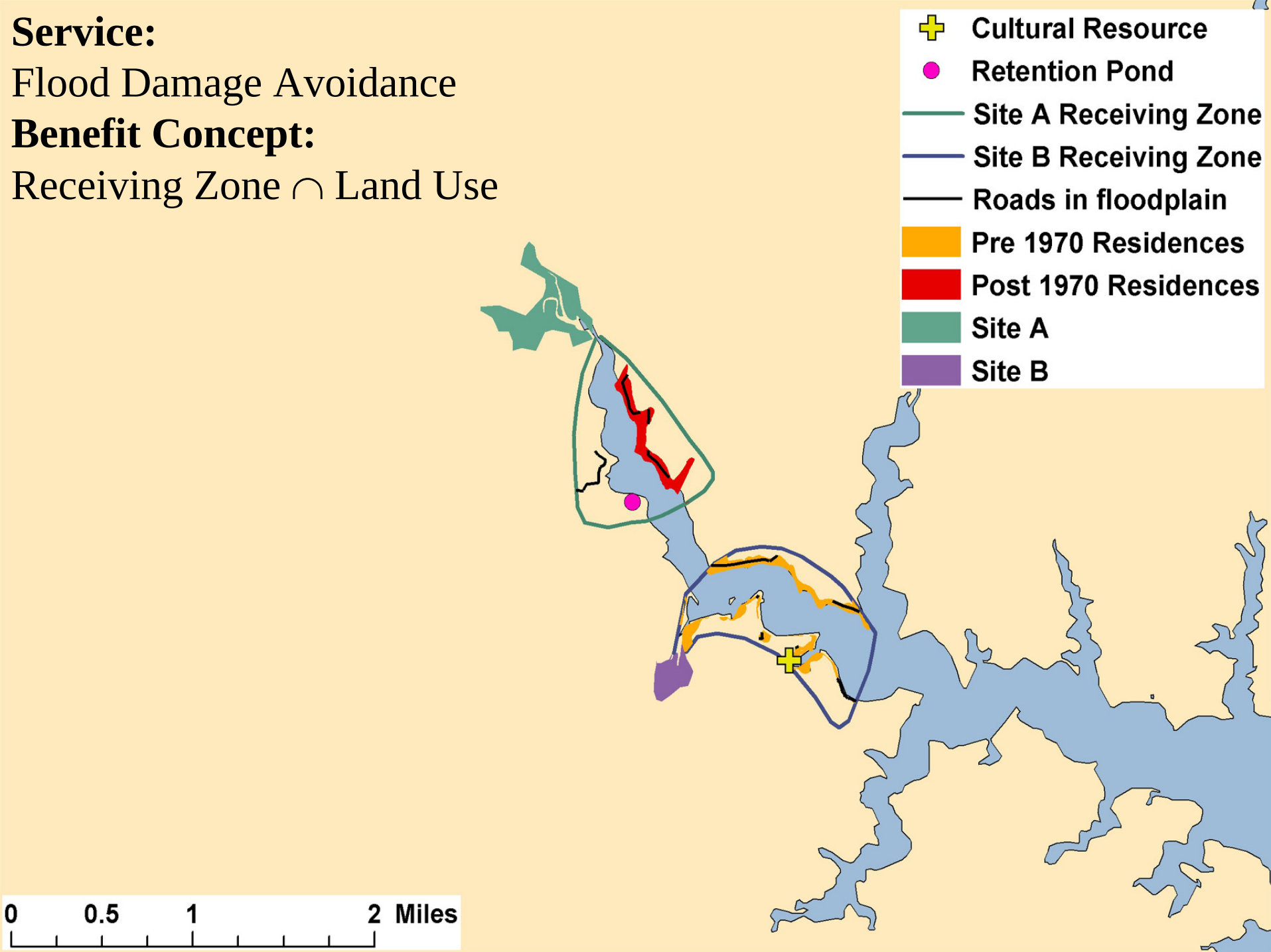
**Service:**
Flood Damage Avoidance
**Benefit Concept:**
Generating Zone ∩ Land Use



**Service:**
Flood Damage Avoidance
**Benefit Concept:**
Receiving Zone ∩ Land Use



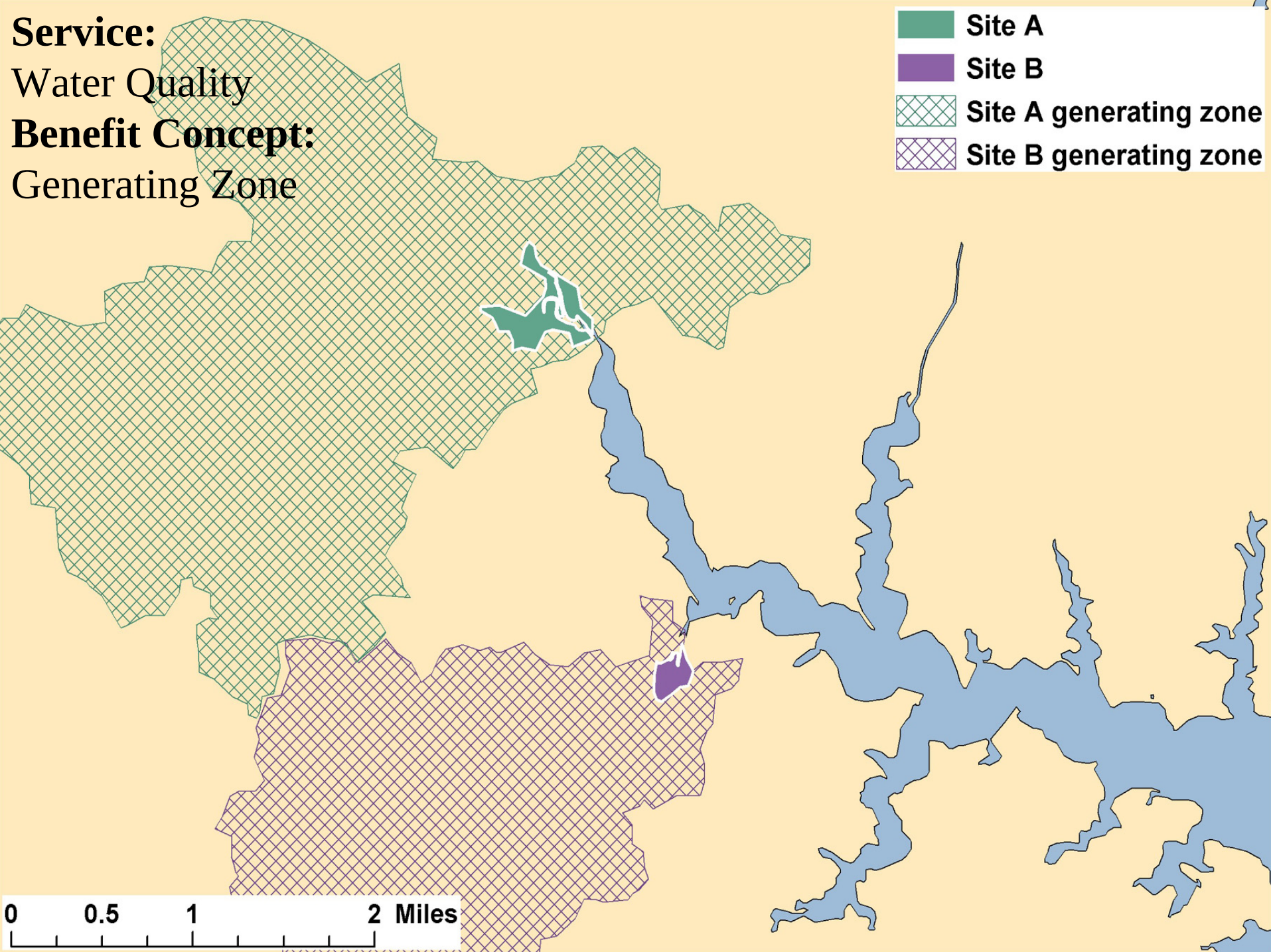
**Service:**
Flood Damage Avoidance
**Benefit Concept:**
Receiving Zone ∩ Land Use



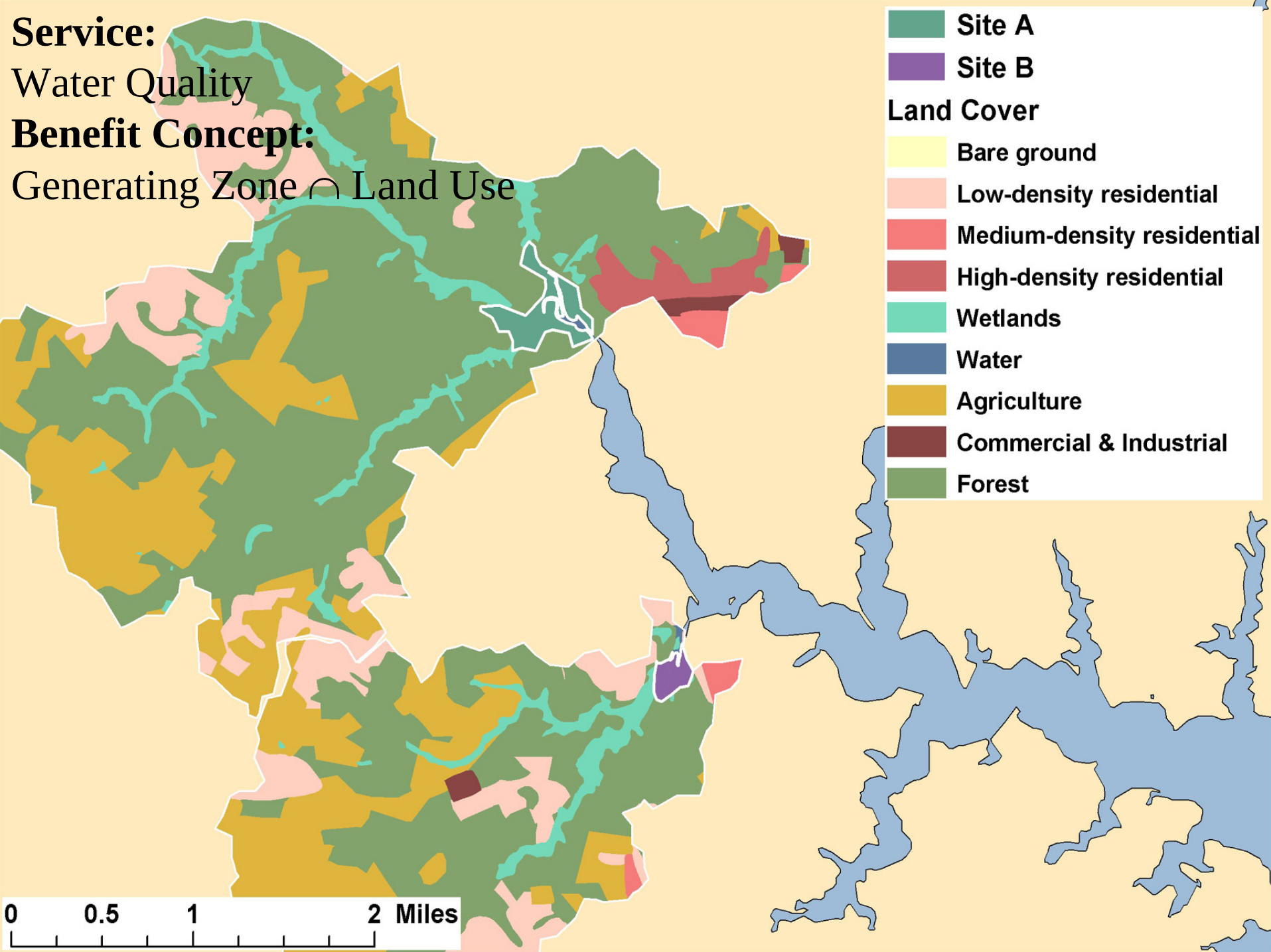
# Flood Avoidance: Sample Indicators

- *Risk:* Percent of generating zone impermeable
  - A: 23% B: 5%
- *Damage avoided:* Value of housing in receiving zone
  - Value of pre-1970 housing
- *Substitutes*: Percent of generating zone natural land cover

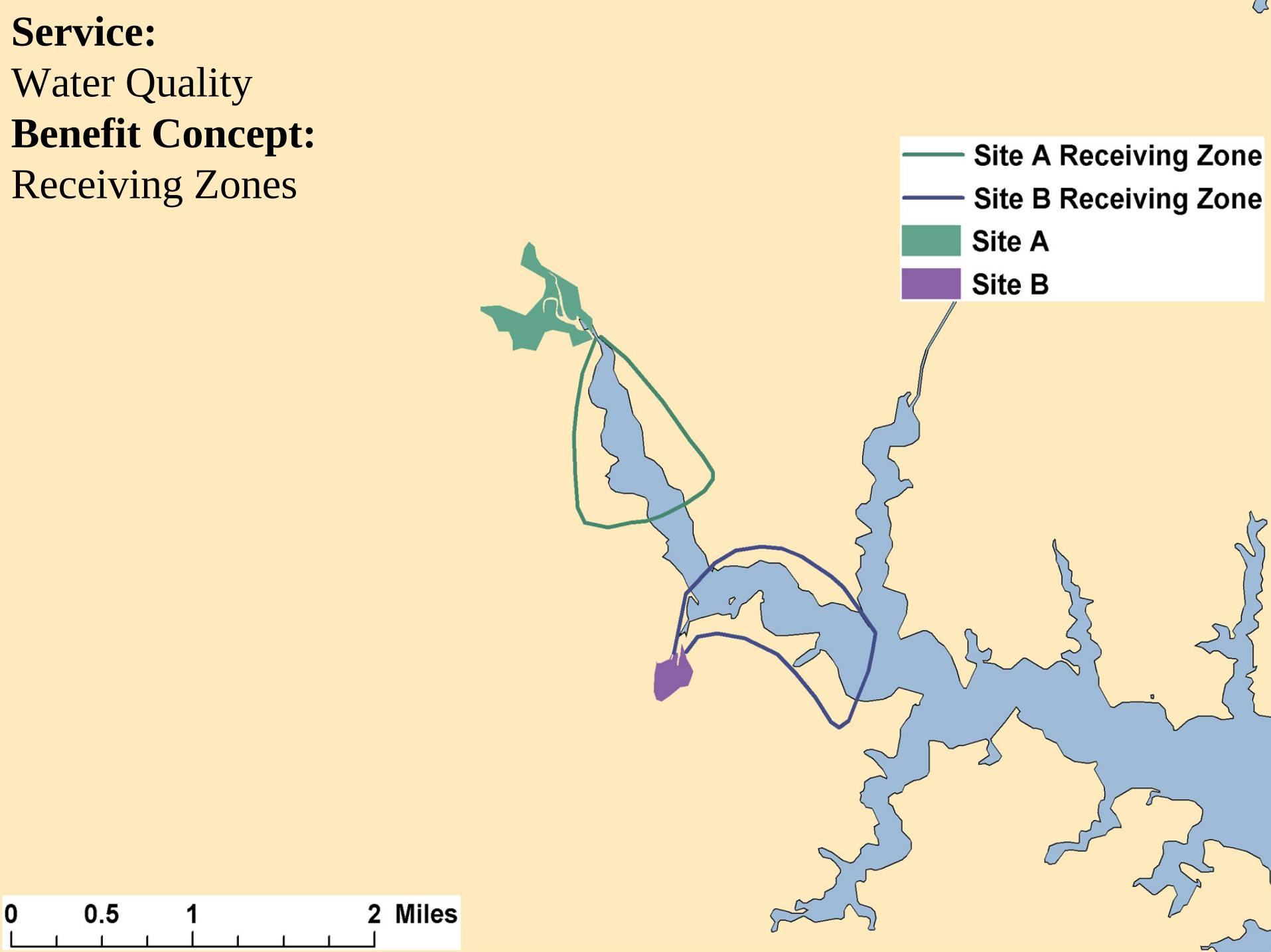
**Service:**
Water Quality
**Benefit Concept:**
Generating Zone



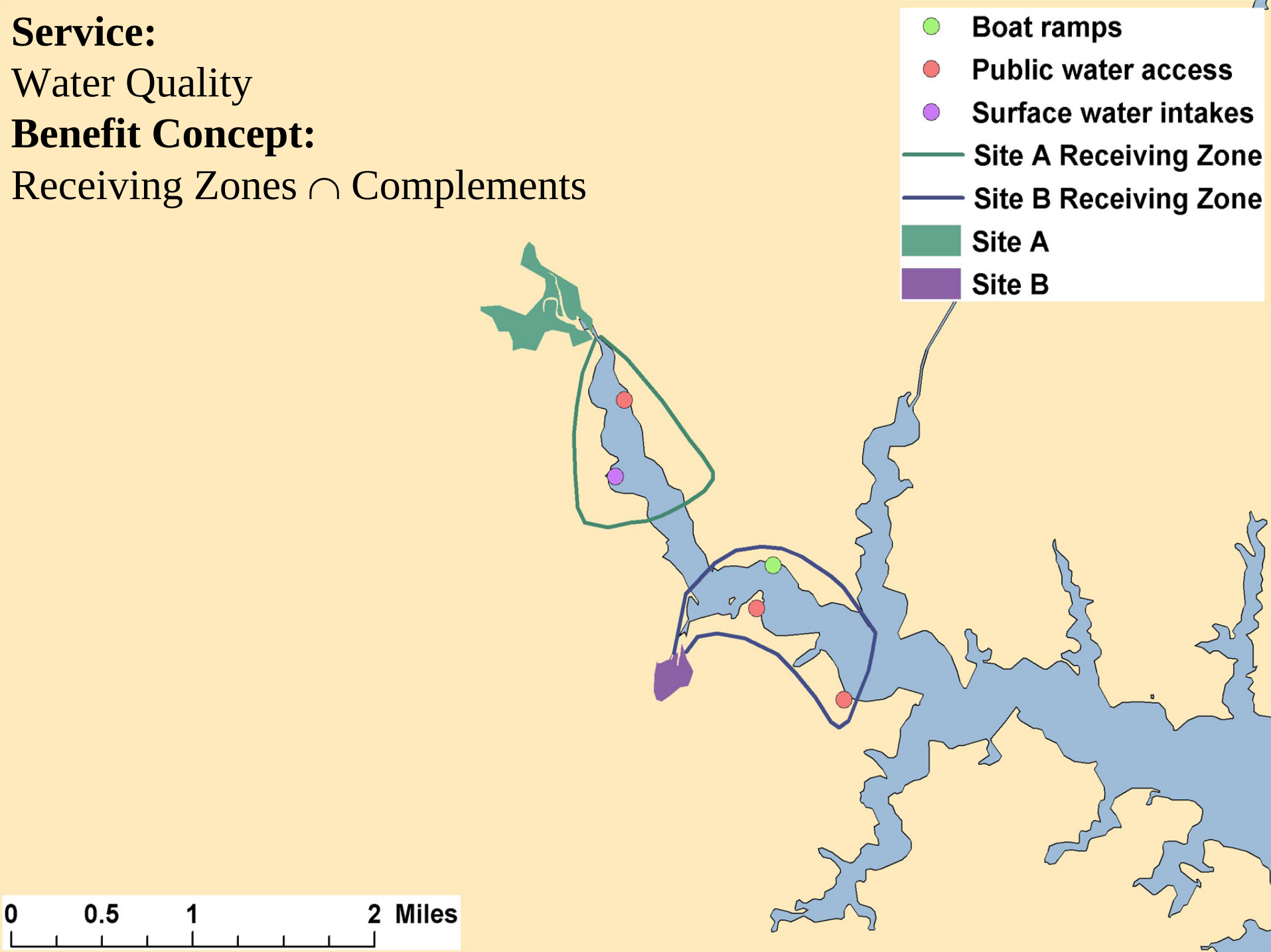
**Service:**
Water Quality
**Benefit Concept:**
Generating Zone ∩ Land Use



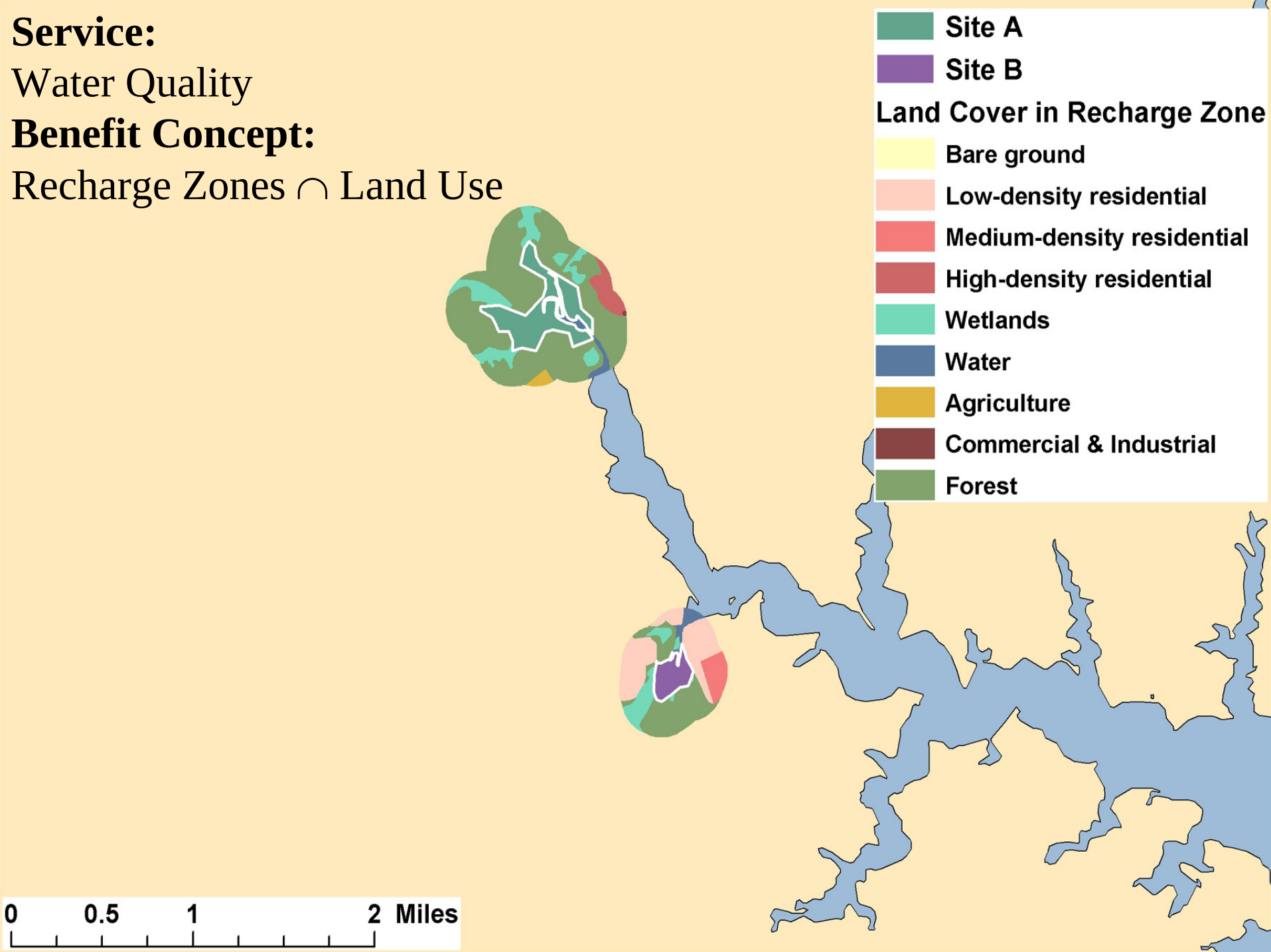
**Service:**
Water Quality
**Benefit Concept:**
Receiving Zones



**Service:**
Water Quality
**Benefit Concept:**
Receiving Zones ∩ Complements



**Service:**
Water Quality
**Benefit Concept:**
Recharge Zones ∩ Land Use

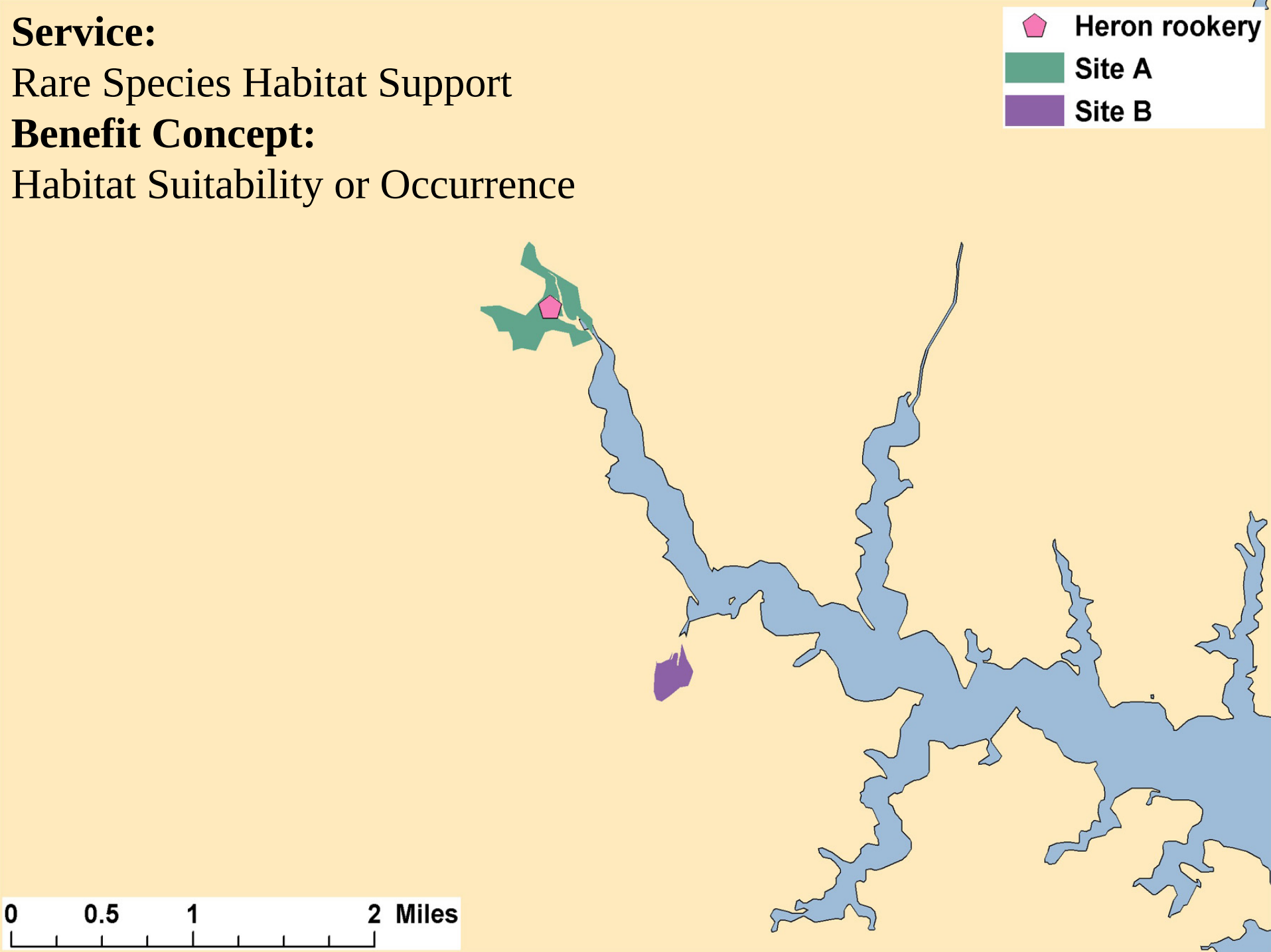


**Service:**

Rare Species Habitat Support

**Benefit Concept:**

Habitat Suitability or Occurrence



# Summary

- Visual and quantitative depiction of
  - Services
  - Factors affecting scale +/-
- Integrated biophysical & socioeconomic
  - Data
  - Interdependencies
- Does not calculate “the answer”
- A framework
  - Depicts underlying complexity
  - Depicts gaps in knowledge & uncertainty
- Ideally, it teaches

# Flexible Tool vs. Replicable Method

- For a method propose and defend
  - Taxonomy of Services (Benefit Types)
  - Core economic principles
  - Core ecological principles
- Make choices, stick with them, but allow the science to update
  - E.g., definition of “service area,” “recharge zone,” “land use threats”

# Other Applications

- Regional, national Benefit Hotspot Mapping
- GPRA reporting, RIAs
  - Monetize, *quantify*, discuss
- National-level indicators, not just regional or local

# Benefit Discovery and Choice

- Collaborative (democratic) processes can create, reveal and aggregate preferences and make tradeoffs
- Can easily get too glib when using terms like democracy, collaboration, stakeholder participation etc.
  - Limits to Consensus
  - Every decision is not “win win”

# Benefit Discovery and Choice as a "Game"

- The challenge for valuation through a collaborative process is two fold
  - rules for the process
  - analytical support for value discovery

# Some Design Lessons from the Theory of Games and Negotiation

- Representation - Who and how selected
- Limit BATNA for any participant
- Limit the opportunity for cost shifting
- Decision rules affect negotiating behavior
  - Consensus, voting rules, etc.
  - Assure compensation side payments
- Analyst – Facilitator Role
  - shift from distributive to integrative bargaining mind set
  - Include institutional as well as physical change alternatives
  - Identify Multi-attribute preferences to expand the decision space

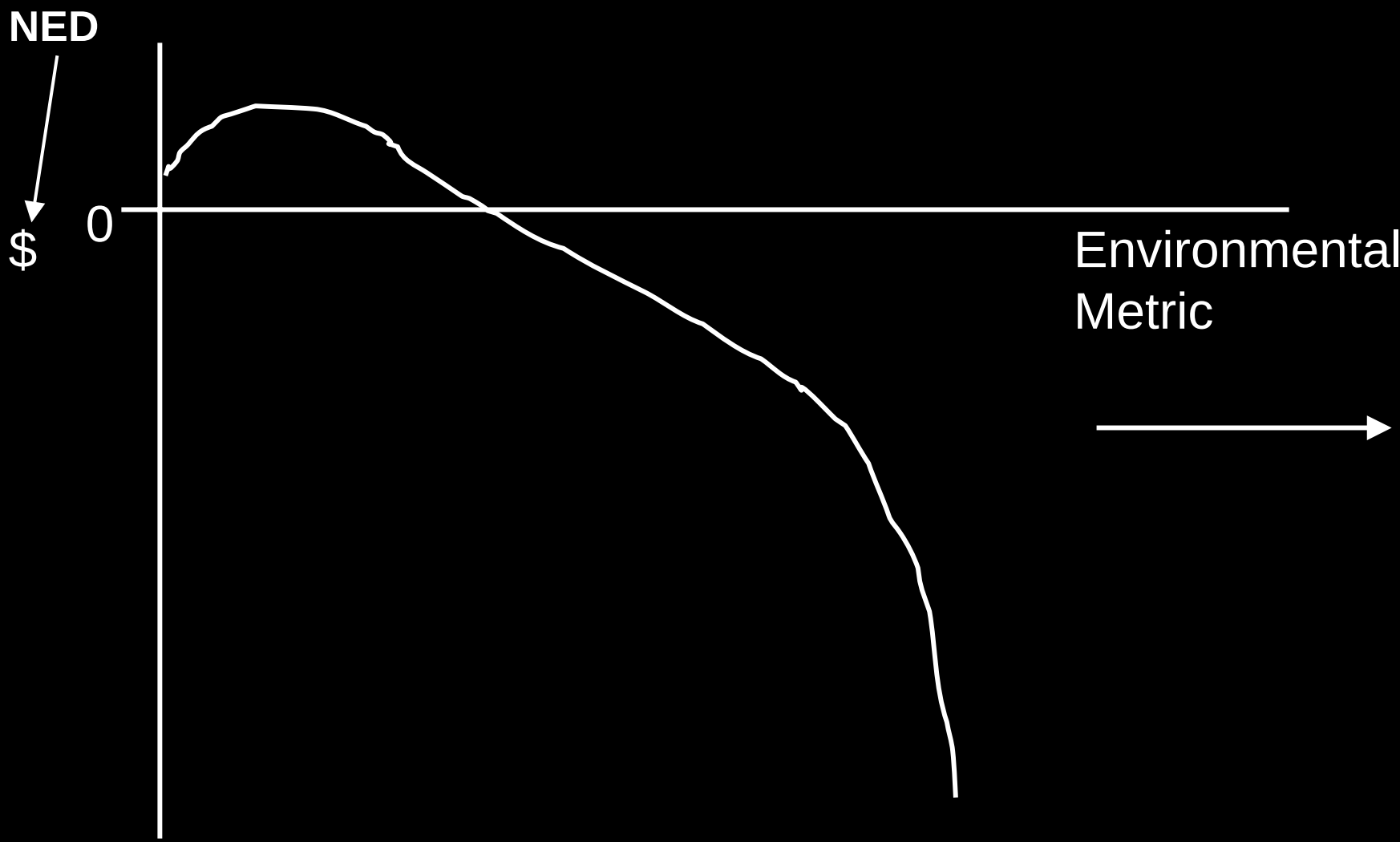
# What is the value of an added acre of wetlands restoration north of the city of Humphries?

Humphries City has a flooding problem

Its about a watershed

Its about services of an environmental asset

***Measured*** **NET**



# Representing Wetlands

- Structure
  - Area
  - Landscape position
  - Soils and Vegetation Cover
- Function
  - Hydrologic mediation
  - Sediment, nutrient and other cycles
  - Nursery and food area

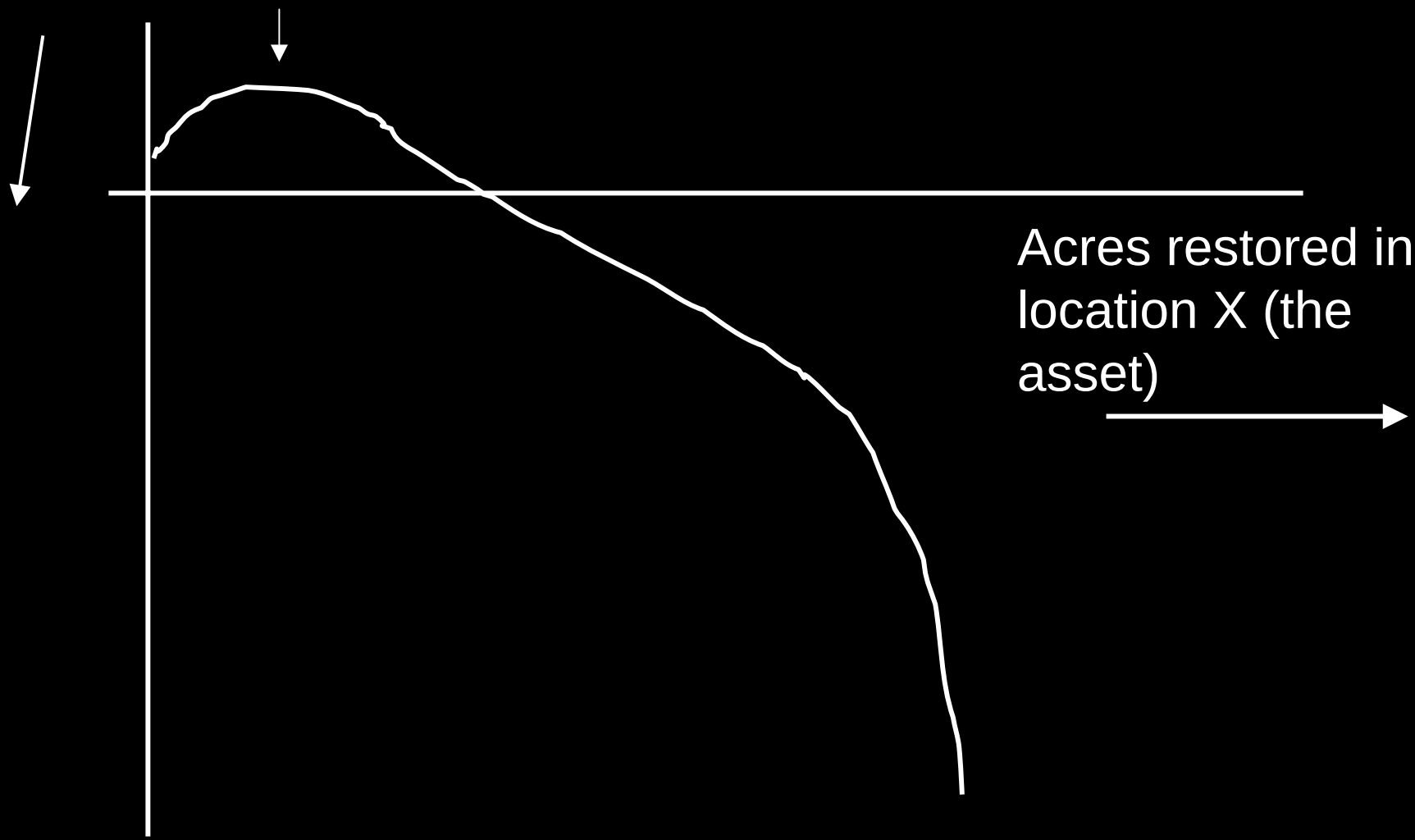
- Services (alone or composite)
  - Flood peaks and velocity
  - On site
    - Recreation
      - Bird watching
      - Consumptive uses
  - Off site
    - Recreation ..
      - Hunting
      - Fishing
  - Commercial Harvest
    - Timber
- Monetized Value to people  (Benefit)

# Representing the Environmental Service

- Must be understood by participants
- Usually has no implicit weighting (HEP, WET,etc.)
  - Unless understood as a argument in preference function (ex. a measure of “biodiversity”)
- Tends to be structure or function
  - Services and value relates to the discovery and debate over significance (more below)

# Measured Net Benefits

- Expenditures on
  - Wetlands restoration
  - Wetlands enhancements
  - Savings in construction of added levee height
- "Credible" monetization of benefits
  - Technically Sound
    - All services – flood risk to recreation to??
  - Acceptable to stakeholders
    - Familiarity –Market analogues
    - Tractability – Time data, etc
    - Technical agreement / Professionally responsible


Acres restored in location X (the asset)

# Discovering “Value”

- Value indicators as a way to organize the deliberation, in relation to marginal cost
- “Credible” monetization is used, not ignored
- Other metrics are part of the deliberation
  - Institutional recognition
  - Legal Requirements (rebuttable presumption)
  - Etc.

# What is the Significance for Corps Planning?

- Monetization is policy AND method decision
  - A technician can always give you a number
  - Ask this: Is monetization “credible” and useful?
    - Technically
    - To the relevant decision makers and stakeholders
- Move Forward with Valuation in Collaborative Process
  - More attention to “science” of process design
  - Build on the current incremental justification framework
    - Foster learning and value discovery
    - Measure what you do measure well
    - Explore the potential of value indicators
    - Develop and apply skills in meditated modeling

# Benefits of Wetlands Protection: Formulation and Evaluation

- 1970s - Charles River, Boston - Corps
  - Flood peaks and velocity with versus without upstream wetlands
  - Benefits of wetlands protection exceed costs
    - $$ damages avoided
    - Talk about intangibles
    - Describe environmental outcomes in physical units
- 2005 – Coast 2050 *and* elsewhere – Corps
  - Storm surge protection, flow modulation as ancillary
  - No expectation of calculating $$ benefits
  - Seeking $$ measures of *other* “environmental services”

# What does OMB really want?

- Benefit Measurement is the tip of the iceberg. Comments on benefits are often a means to a broader inquiry.
  - Why is this a governmental/ federal government problem
  - Share the decision making in plan formulation- esp. definition and design of alternatives
  - Documentation of incremental justification, and implicit risk judgments. The sound science debate – dam safety and engineering standards

# Advocacy

- Win and Argument
  - Worth Saving that wetland acre, or not
- Public Relations
  - What is the Air Force base worth in addition to jobs?
  - Coast 2050
  - Value of the Earths Services
- Basis for Negotiating Damage Awards
  - Trustees
  - Legal Proceedings

Cover Your ….

“The appeal of numbers is especially compelling to bureaucratic officials who lack the mandate of a popular election, or divine right. Arbitrariness and bias are the most usual grounds upon which such officials are criticized. A decision made by the numbers (or by explicit rules of some other sort) has at least the appearance of being fair and impersonal. Scientific objectivity thus provides an answer to a moral demand for impartiality and fairness. Quantification is a way of making decisions without seeming to decide. Objectivity lends authority to officials who have very little of their own.” (Porter, p. 8, *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life*, )

# Administrative Efficiency

- Set Budget Priorities
  - Intangibles are always and have been present
- Expedite planning and decision making (Look up tables)
  - Appeal to Authority for Justification
  - Try doing this for mitigation